

Fiberglass Production

The fiberglass reinforced plastics industry in Washington produces a range of products including boats, auto and truck canopies, aircraft parts, corrosion resistant tanks and piping, shower stalls, bathtubs, spas, marbled products, and a variety of specialty items from skis to sail boards.

There were 55 fiberglass resin product businesses in Washington that were large enough to be involved in the Pollution Prevention Planning program, but over 1,000 businesses were listed in associated Standard Industrial Classification (SIC) codes. The largest single category in Washington is boat builders. Other SIC codes with known fiberglass resin product businesses in Washington are listed in Figure 1 with the number of facilities in Washington. The pollution prevention plans and yearly updates give good insight into each plant's processes, raw material usage, and pollution prevention activities with accompanying reduction trends of emissions.

Fiberglass Manufacturing
Figure 1. Standard Industrial Classification (SIC) Codes in WA State
 (Ecology, 1/20/98)

| SIC | SIC Description | No. of Facilities |
|------|--------------------------------------|-------------------|
| 3081 | Unsupported plastics film and sheets | 7 |
| 3084 | Plastic Pipe | 14 |
| 3088 | Plastics plumbing fixtures | 11 |
| 3089 | Plastics products, nec | 67 |
| 3433 | Heating equipment, except electric | 5 |
| 3713 | Truck and bus bodies | 21 |
| 3728 | Aircraft Parts and Equipment | 99 |
| 3732 | Boat building and repairing | 228 |
| 3949 | Sporting and athletic goods, nec | 32 |

Description of Process

The most common method of reinforced plastics production is open molding. Boat manufacturing is typical and will be used as an example. First the surface of the mold is polished and coated with a wax, which allows easy removal of the finished product from the mold after curing. Next gel coat, consisting of unsaturated polyester resin, catalyst, and pigments, is sprayed onto the waxed mold. This forms the outer, visible surface of the boat.

After the gelcoat is fully cured, fiberglass reinforcing material saturated with catalyzed polyester resin is applied over it. Methods of application are: (1) chopper gun (spray coat) - the resin, catalyst and fiberglass strand are fed into a gun, and the fiberglass is chopped into short segments and sprayed with the resin into the mold; (2) hand layup - the resin is catalyzed, then brushed on to layers of glass mat or roving which have been hand fitted into or over the mold. Air bubbles and other imperfections are removed by rollers, by hand. Tools are cleaned periodically of resin, using acetone or a substitute cleaner before the resin begins to polymerize.

After the lay-up is cured, it is trimmed, removed from the mold, and manufactured into a boat or other finished product.

Methods of Determining Emissions

Air emissions data on the fiberglass resin product industry in Washington state is available from the Washington Emissions Data System (WEDS), Toxic Release Inventory (TRI), and the Pollution Prevention Planning effort of Ecology's Hazardous Waste and Toxics Reduction Program. National emissions estimates are also available from EPA.

Total national VOC emissions from fiberglass boat manufacturing are estimated to be 20,150 tons per year (U.S. EPA, May 1990). Approximately, 64 % of these emissions are styrene, resulting from gel coating and lamination; the remainder is acetone or some other solvent used during clean-up.

There are four primary areas in the fiberglass boat production processes where VOC may be emitted to the atmosphere. These are resin storage, the production area, the assembly area, and waste disposal. The major emission sources are exhausts from gel coat spray booths, room exhausts from the lamination area, and evaporation of acetone or other solvents during clean-up. Styrene emissions occur during the lamination of the deck, hull, and small parts, due to evaporation from the resin or gel coat over-spray and from vaporization from the applied resin or gel coat before polymerization occurs.

Emissions should be calculated using actual resin monomer contents. When specific information about the percentage of styrene is unavailable, the representative average values in AP-42's¹ Table 4.12-3 should be used. The sample calculation illustrates the application of the emission factors.

Parameters needed for estimating styrene emissions will be:

- process type to choose appropriate emission factor.
- resin quantity used
- resin monomer type, percent, and whether vapor stabilized or not

Acetone and other solvent emissions should be estimated using:

- amount of solvent purchased
- solvent sent offsite (disposal, recycling, etc.)
- any other appropriate material balance considerations

Sample Calculation A fiberglass boat building facility consumes an average of 250 kg per day of styrene-containing resins using a combination of hand layup (75%) and spray layup (25%) techniques. The laminating resins for hand and spray lay up contain 41.0 and 42.5 weight percent, respectively, of styrene. The resin used for hand layup contains a vapor-suppressing agent.

¹ U.S. Environmental Protection Agency, *Compilation of Air Pollutant Emissions Factors Volume 1: Stationary Point and Area Sources*, Fifth Edition with Supplements, October 1997, Document No. AP-42.

From Table 4.12-2 of AP-42 the factor for hand layup using a vapor suppressed resin is 2 - 7 (0.02 to 0.07 fraction of total styrene emitted); the factor for spray layup is 9 - 13 (0.09 to 0.13 fraction emitted). Assume the midpoints of these emission factor ranges.

Total VOC emissions are:

(250 kg/day) [(0.41)(0.045)(0.75) + (0.425)(0.11)(0.25)] = 6.4 kg/day.

Emissions from use of gel coat would be calculated in the same manner. If the monomer content of the resins were unknown, a representative value of 43 percent could be selected from Table 4.12-3 for this process combination. It should be noted that these emissions represent evaporation of styrene monomer only, and not of acetone or other solvents used for cleanup.

Another source of emission factors is from a masters thesis study that Stacia Dugan and Dr. Michael Pilat of the University of Washington did on styrene emissions from Philips/Hytec (now called Lasco Products) in Yelm, Washington in August, 1990. Philips/Hytec manufactures fiberglass tubs and showers. It is left up to the reader whether they represent valid emission factors. They imply that from 30 to 65 percent of the styrene in the various resins is emitted to the air during processing.

The EPA, National Marine Manufacturing Association, and the Composites Manufacturing Association are currently (1998) sponsoring and evaluating additional testing to update styrene emission factors. These tests will probably bring a revision to the current AP-42 emission factors, which will probably result in an increase in emission factors.

Acetone and other volatile solvents are almost all emitted to the air, so the emission factor for volatile cleaning solvents is essentially 1.0. A material balance between purchased acetone and any acetone in wastes sent offsite will be the best estimate of air emissions. Other solvent usage can be done similarly.

The Puget Sound Air Pollution Control Authority (PSAPCA) Regulation II, Section 3.08 Polyester, Vinylester, Gelcoat, and Resin Operations (revised 12/09/93) requires fiberglass resin product businesses to register with the agency, and use an enclosed, vented spray area. It also sets spray gun specifications, and sets controls on volatile clean-up solvents.

One of two federal National Emission Standards for Hazardous Air Pollutants (NESHAP) will be applicable to fiberglass manufacturers that emit more than 10 tons of styrene into the air. Boat manufacturers will be covered under the Fiberglass Boat Manufacturing NESHAP, and all other fiberglass manufacturers will be covered by the Fiberglass Reinforced Plastics Composites NESHAP. Both federal rules are due in proposed form in 1999, and final rule in 2000. The EPA contact is Madeleine Strum at (919) 541-2383 or e-mail at strum.madeleine@epamail.epa.gov. Bob Burmark (Ecology) and Bob Goldberg (Ecology) are participating with the EPA, states, and the fiberglass industry to develop these federal rules.

Fiberglass manufacturers that emit less than 10 tons per year of styrene will not be subject to these NESHAPs, but are subject to all other applicable federal, state, and local regulations.

It is projected that several fiberglass manufacturers in Washington will be permittable due to styrene emissions greater than ten tons. Acetone is exempt from federal and state VOC reporting because it has a negligible contribution to ozone formation.

References

U.S. Environmental Protection Agency, *Assessment of VOC Emissions from Fiberglass Boat Manufacturing*, May 1990, EPA-600/2-90-019. EPA's Control Technology Center at Research Triangle Park, NC, Charles H. Darvin Project Officer.

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Washington State Department of Ecology, *Pollution prevention planning annual reports and yearly updates*. Available from the Ecology Regional Offices. Ecology statewide fiberglass resin product contact: Bob Goldberg @ (360)407-6350.

Washington State Department of Ecology, *Washington Emissions Data System (WEDS)*, Contact: Sally Otterson, 360-407-6806.

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